



GCE AS LEVEL CHEMISTRY

S21- B410

Assessment Resource B

Energy, Rate and Carbon Compounds

1. Explain the meaning of the term heterolytic bond fission. [1]

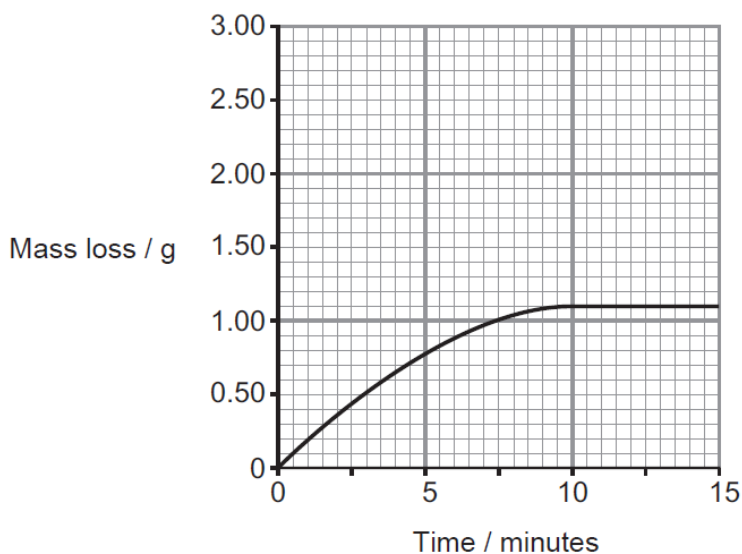
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2. Explain how a catalyst speeds up a reaction. [2]

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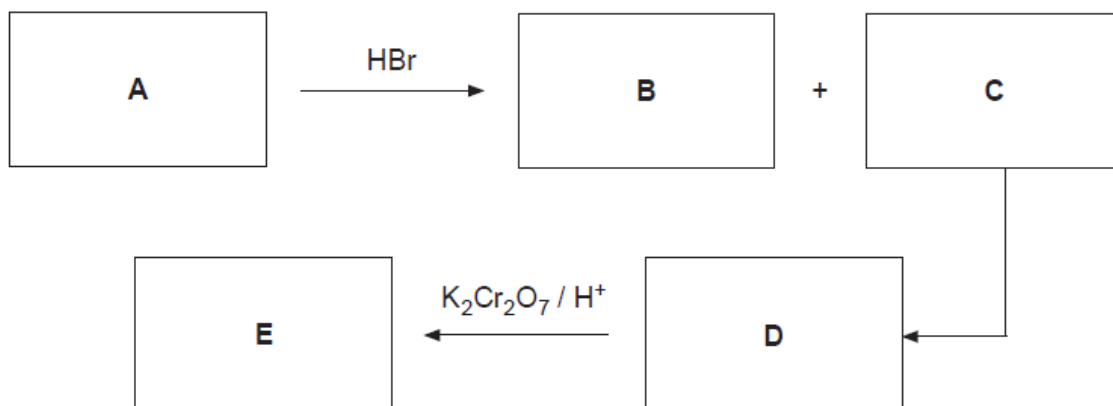
3. The rate of the reaction between calcium carbonate and acid can be found by measuring the loss in mass of the reactants over time.

The graph below shows the results obtained when a large excess of calcium carbonate was added to 50.0 cm³ of 1.00 mol dm⁻³ hydrochloric acid at room temperature.



- (a) **On the grid**, sketch the curve that would be obtained if the experiment were repeated at 60 °C with all other conditions being unchanged. Label this curve **A**. [1]
- (b) **On the grid**, sketch the curve that would be obtained if the experiment were repeated using 2.00 mol dm⁻³ hydrochloric acid with all other conditions being unchanged. Label this curve **B**. [1]

4. (a) Study the reaction scheme shown below and the other information about compounds **A-E** that follows.



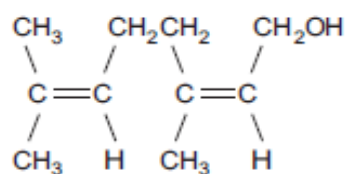
Compound **A** is a straight-chained gaseous hydrocarbon.

Compounds **B** and **C** are isomers.

Compound **E** reacts with sodium hydroxide in a 1:1 molar ratio.

0.412 g of compound **E** in aqueous solution requires 23.40 cm³ of sodium hydroxide solution of concentration 0.200 mol dm⁻³ for complete neutralisation.

- (b) Geraniol is one of the main constituents of rose oil and is widely used in perfumes and flavourings. Its structure is shown below.



- (i) Name the functional groups present in the compound. [1]

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- (ii) State the molecular formula of the compound. [1]

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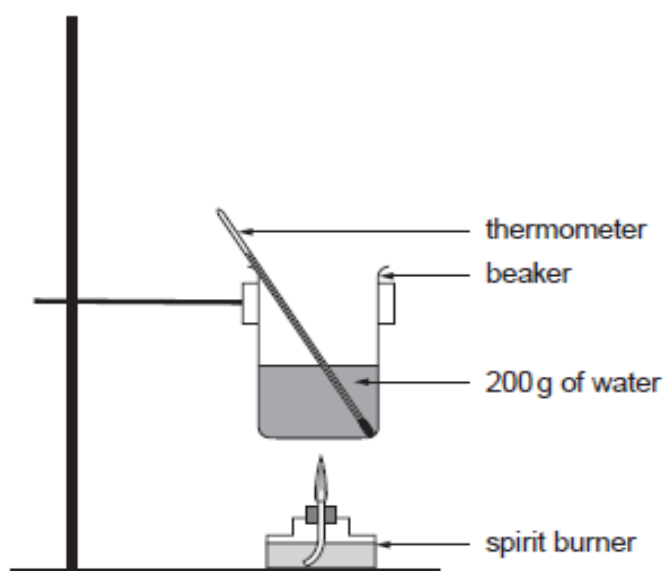
- (iii) Draw the structure of an organic product formed when geraniol reacts with

- I. Br_2 [1]

- II. CH_3COOH in the presence of sulfuric acid [1]

5. Pentan-2-ol, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$, is one of the isomers of $\text{C}_5\text{H}_{11}\text{OH}$. It has a relative molecular mass of 88.1.

A student carried out an experiment on a sample of pentan-2-ol to determine its enthalpy of combustion using the apparatus shown below.



The spirit burner was lit and allowed to burn for a few minutes before it was extinguished.

The following results were recorded.

Initial temperature of the water	18.6 °C
Final temperature of the water	25.4 °C
Initial mass of spirit burner and pentan-2-ol	97.60 g
Final mass of spirit burner and pentan-2-ol	97.42 g

- (a) Calculate a value for the enthalpy change of combustion of pentan-2-ol in kJ mol^{-1} . [4]

$$\Delta_c H = \dots\dots\dots \text{kJ mol}^{-1}$$

- (b) (i) Each reading on the thermometer is accurate to $\pm 0.1^\circ\text{C}$. Calculate the percentage error in the temperature difference recorded. [1]

$$\text{Percentage error} = \dots\dots\dots \%$$

- (ii) Suggest how, using the same apparatus, the experiment could be improved to reduce this percentage error. Explain your answer. [2]

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- (c) (i) Suggest an experimental improvement that would reduce error due to heat loss. [1]

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- (ii) Suggest one reason, other than heat loss, why the value obtained for the enthalpy change of combustion is smaller than the theoretical value. [1]

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- (d) Another isomer of $C_5H_{11}OH$ is 2-methylbutan-2-ol, $(CH_3)_2C(OH)CH_2CH_3$. Standard enthalpy changes of combustion, $\Delta_c H^\ominus$, can be found using standard enthalpy changes of formation, $\Delta_f H^\ominus$.

The table shows some standard enthalpy changes of formation.

Substance	$\Delta_f H^\ominus / \text{kJ mol}^{-1}$
$(CH_3)_2C(OH)CH_2CH_3(l)$	-380
$O_2(g)$	0
$CO_2(g)$	-394
$H_2O(l)$	-286

- (i) Write an equation for the complete combustion of $C_5H_{11}OH$. [1]

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- (ii) Use the values in the table and the equation in part (i) to calculate the standard enthalpy change of combustion, $\Delta_c H^\ominus$, of 2-methylbutan-2-ol. [2]

$$\Delta_c H^\ominus = \dots\dots\dots \text{kJ mol}^{-1}$$

- (iii) State why $O_2(g)$ has a value of zero for its standard enthalpy change of formation, $\Delta_f H^\ominus$. [1]

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- (e) A student was given separate samples of pentan-2-ol and 2-methylbutan-2-ol but was not told which was which.

Describe a chemical test that the student could use to clearly distinguish between the alcohols. Give any reagent(s) used and expected observation(s) for both compounds. [3]

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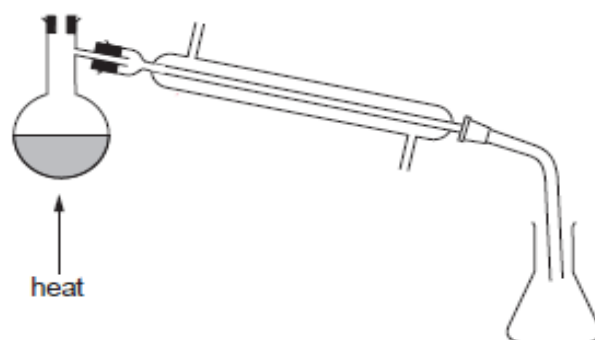
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- (f) Another student wanted to make pure 2-chloro-2-methylbutane from 2-methylbutan-2-ol in a multi-step process. One of the steps used was distillation.

- (i) An incomplete diagram of the distillation apparatus is shown below.



Complete the diagram by drawing a thermometer and clearly labelled arrows to show the flow of water into and out of the condenser. [2]

- (ii) The student predicted that since this was a multi-step process the overall yield would be less than 70%.

In the process, 5.00 cm³ of 2-methylbutan-2-ol were used and 4.05 cm³ of 2-chloro-2-methylbutane were made.

Is the student correct? Use the following information to justify your answer. [3]

Compound	Density / g cm ⁻³
2-methylbutan-2-ol	0.805
2-chloro-2-methylbutane	0.866

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

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